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THE PHYSIOLOGICAL EFFECTS OF MASSAGE.

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ALTHOUGH massage has of late years gained ground in the estimation of medical practitioners as an adjunct of some value to other forms of medical treatment, the results following its employment have not received the attention which they appear to deserve, and with the exception of the experiments made by Zabludowski, von Mosengeil, and Gopadze, few observations have been made on the immediate and remote effects of systematic massage practised on healthy individuals. Moreover, in most instances of its use as a remedial agent the actual practice has been left almost entirely in the hands of persons, who, although some of them may be dexterous manipulators, are ignorant of the structure and functions of those tissues on which they are called to operate, and who appear each one to have his or her own peculiar views as to the mode, duration, and desired result of the process.

It is difficult to describe in writing the various manipulations included under the term *massage*, and as yet no one has succeeded in producing such a word-picture as would enable a person who has not witnessed the practice to follow the description and carry out the movements, to be acquired only by those who have patience to learn, and dexterity to perform, the forms of handling which go to make up the process. For the purpose of the following observations it will be sufficient briefly to describe the manipulations, with their immediate physiological effects, as noted by the writer in the course of a series of experiments, undertaken with a view to enquire into the actual value of massage *per se* as a remedial agent.

Objections have been raised to the use of French terms employed throughout the Continent in the nomenclature of the various manipulations described below; the writer has therefore sought to replace them when practicable by their English equivalents.

Rubbing (*effleurage*) consists in gentle stroking, gradually increasing in strength to moderately firm rubbing, of the skin with the flat palmar surface of the hand in a linear direction, the firmer friction being always employed in the direction of the blood-current towards the heart; and in the case of the limbs both hands should be used to grasp the whole circumference of the extremity when possible, the heel of the hand being used somewhat vigorously over large muscular masses, while in the small areas of the feet and hands, and over bones unprotected by muscles, the palmar surface of the thumb only is employed. One of the earliest effects of this manipulation is the stimulation of the *arrectores pili*, producing the condition known as "goose-skin," the contraction of these muscles compressing the contents of the sebaceous follicles, and with the friction exercised by the operator's hand aiding in removing the secretion. This effect, however, ceases on the application of the firmer friction, which produces dilatation of the superficial cutaneous blood-vessels, with accompanying redness of the part; insensible perspiration usually follows, and rarely sensible perspiration; but when this occurs the strength of the friction has been pushed beyond the limit one assigns to this stage of massage, the effect on the subject being similar to that produced by a hot bath, beads of perspiration forming on the surface after some minutes' vigorous rubbing.

The subjective sensations of persons at this stage vary very greatly, but after a few minutes the skin reflexes, especially in subjects in which they have been feeble or retarded, are more easily excited than before. The soothing effect on the sensorium of stroking the skin has invariably followed when employed by the writer on healthy persons ; but the most remarkable effect of this form of massage acting on the cutaneous nerve-endings appears to be identical with that which Naumann has shown to follow weak electrical stimulation of the skin of the frog ; viz. acceleration of the circulation with increased rapidity of the heart's beat. This result may be obtained by "rubbing," whether before or after "kneading," by no means an unimportant fact to remember when practising massage in certain cases.

Kneading (*pétrissage*) is the term applied to the centripetal pressing and rolling of the skin and muscles by the hand in the second stage of massage, the manipulations varying in fashion and force with the part under treatment. The effect of thus dealing with skeletal muscles is very remarkable, and upon it the value of general corporeal massage in a great measure depends. By the initially light and gradually firmer centripetal friction of the surface the venous blood and lymph are mechanically forced onwards through their respective superficial vessels, and in this way the rapidity of the cutaneous capillary and arterial circulation is increased, as also that of the venous and lymphatic trunks lying at a deeper plane ; then in rolling the skin over the superficial fasciæ the vessels of these tissues are similarly acted on, and pursuing the process to the deeper movements, in which the fasciæ and muscles are thoroughly kneaded, a series of events occurs similar to, if not identical with, those described by physiologists as the result of muscular action ; indeed, it is the duty of the *masseur* to apply intermittent and rhythmical kneading to each muscle or group of muscles so as to simulate as far as possible Nature's own provision for the maintenance of the circulation through the tissues. "When the muscles are in action, not only is the lymph poured out more rapidly, but more lymph is formed. The tendons and fasciæ of the muscles of the skeleton, which are provided with numerous small stomata, absorb the lymph from the muscles. By the alternate contraction and relaxation of these fibrous structures they act like suction-pumps, whereby the lymphatics are alternately filled and emptied, while the lymph is propelled onwards. *Even passive movements act in the same way.*"[1] "The fascia consists of two layers of fibrous tissue with intervening lymphatics. When a muscle contracts, lymph is forced out from between the layers of fascia, while when it relaxes the lymph from the muscle, carrying with it the waste products of muscular action, passes out of the muscle into the fascia, between the now partially separated layers" (Brunton). "Every pressure upon the vessels and tissues aids the current" (Ludwig). Kneading mechanically forces the lymph from the spaces into the vessels, whence it is prevented flowing back by the valves, and at the same time the circulation of the blood through the arteries and capillaries of the muscles must be accelerated so that the absorption of waste products is increased, the nutrition of the parts is improved, and as pressure is exercised on the deep veins, they are alternately emptied and filled by rhythmical massage, while the circulation through the arteries being intermittently checked the vessels above the point of pressure become dilated, and when this temporary compression is relieved blood flows into the part with greater force and rapidity, thus increasing the velocity of the circulation through the part under treatment. Temporary decrease in the circumference of a limb has been pointed out as a result of kneading by Dr. Douglas Graham, and similar results were obtained by the writer, who in one case found three-fourths of an inch decrease in the circumferential measurement of the thigh after ten minutes' deep kneading of the limb; the same result following in another case after fifteen minutes' manipulation. This decrease must be regarded as evidence of a diminution of the fluids in the tissues, and points to a temporary unloading of the efferent vessels of the part, and consequent replenishment of the muscles acted upon.

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[1] Landois and Stirling, *Human Physiology*, vol. i. p. 414.

Kneading has been long recognised as a substitute for muscular exercise: but while valuable in this respect, it has also been found to relieve the aching weariness produced by exercise whether in a feeble or vigorous muscle; moreover, massage will not only restore to the fatigued muscle its original power, but will increase its energy.

Experiments made by the writer on able-bodied males not accustomed to gymnastics, being engaged in sedentary pursuits, resulted in a gain of power varying from five to twenty-nine pounds' pressure after massage of the right upper extremities for ten minutes, and in a gain of from seven to twenty pounds' pressure in the case of the left arms of four individuals whose strength was tested by means of Mathieu's dynamometer, graduated by Messrs. Krohne and Sesemann, the subjects being seated at a table, the fore-arms at a right angle to the upper arms, and rising perpendicularly from the plane of the table on which the upper arms rested. The left-hand squeeze was always less than the right before kneading; but in most cases, as in the examples cited from among many in which the experiments gave like results, massage appears to have a more marked effect on the comparatively seldom-used muscles of the left hand than on those of the right.

Zabludowski's experiment—of tiring the muscles of an uninjured frog by a series of contractions rhythmically stimulated by the induction-current till exhausted, and after rest attempting again to induce contractions which failed, while after massage the contractions became almost equal to the first—has been repeated by the writer on the muscles of the human fore-arm with like results, which goes to prove that the electrical contractility of muscle is improved by massage, an effect which has been frequently noted by me when using the faradaic current after massage in cases of nutritional disturbance of the spinal cord.

The same effect of massage in restoring activity and power to an exhausted muscle after over-use has been observed by the writer in a series of experiments carried out by the subject grasping the dynamometer and squeezing it rhythmically until the pressure became so feeble that the index could not be made to travel beyond 5 lbs.: the limb was then rested ten minutes, when there was a gain of less than 5 lbs., the experiment was continued till the indicator hardly moved in spite of great effort. The limb was then subjected to ten minutes' massage and again tested, when the pressure rose to 45 lbs. These experiments have been frequently repeated with different individuals who were ignorant of the possible result with almost invariably remarkable effect, the measurement of the limbs before and after exercise, rest, and rest with massage being taken, with the result that at the period of exhaustion the circumference of the fore-arms has increased in some cases $\frac{3}{8}$ inch, at the conclusion of ten minutes' rest without massage no diminution or increase has occurred, while after massage $\frac{3}{4}$ inch decrease has been noted.

Kneading has therefore an effect on the muscles distinct from that of exercise, and may be said to have certain advantages over exercise for enfeebled patients, in that it demands no voluntary effort; no muscular fatigue is induced, but rather removed; the blood is attracted from the internal organs to the external tissues; while the position of the body during the operation (generally recumbent) tends to the conservation of power instead of its expenditure.

There is little doubt that kneading produces dilatation of the vessels of the part manipulated, and that this is maintained by "tapping;" so when a large area such as the muscles of the limbs and trunk is subjected to "kneading," the tension of the vessels of other parts is reduced, and the rapidity of the heart's action is diminished, but the pressure of the *masseur's* hands on the veins exercised always in an upward or centripetal direction will limit this effect by preventing the retention of blood in the relaxed vessels, forcing it onwards into larger venous trunks, and so maintaining the quantity of blood given with each diastole to the heart, though not to a sufficient extent to prevent reduction in the rate of the circulation. In abdominal massage this centripetal pressure on the venous trunks is not possible, so we find the systemic circulation and heart's action more markedly affected than in the manipulation of the limbs; but whether the reduction in rapidity of the heart's beat is due to the dilatation of the abdominal vascular area or to the stimulation of the sympathetic by the kneading process, the effect of abdominal massage is very marked in healthy individuals, and in neurasthenic and other cases in which there is a feeble circulation, the slowing of the pulse-rate is even more easily brought about.

There is undoubtedly a diminution in the calibre of the vessels of other regions when the abdominal vessels are dilated, and the fact assumes clinical importance when general corporeal massage is practised, for according to the results desired so must we omit, modify, or vary as to period and duration, the practice of abdominal massage.

As an example of the effects produced by "rubbing" and "kneading" respectively, I quote from among many cases in which the pulse-rate has been noted the following, which fairly represents the average result following the different manipulations.

A healthy man, æt. 28, before massage had a pulse-rate of 75 per minute, after "rubbing" (*effleurage*) for ten minutes the general surface of the body the pulse rose to 100; "kneading," excluding the abdomen, was then practised for twenty minutes, at the expiration of which period the pulse fell to 92, when rapid rubbing of the limbs and back was substituted for ten minutes, the pulse rising to 102. Abdominal massage only was then performed for less than ten minutes, and the pulse-rate was found to be reduced to 74 beats per minute.

It is usually the practice of the writer to commence any sitting for general corporeal massage with manipulation of the abdomen, as the depressant effect is most marked, and if massage of this region is deferred till after the extremities have been dealt with, much of the immediate good effect of the process is lost, the extremities of the patient becoming in almost all cases sensibly colder, while the abdomen is being kneaded in spite of careful wrapping and clothing of the rest of the trunk and limbs.

There is one form of manipulation included under the general term massage for which no name has been found to express adequately the nature of the movement; the French *massage à friction* conveys no idea of the manipulation, which consists of a series of rapid circular rubbings with the palmar surface of the hands, and more especially with the finger-tips, combined with strong upward friction of the limb.

This is especially adapted to the manipulation of joints, and is indeed a combination of rubbing and kneading, having for its purpose the distribution and squeezing out of waste products from the tissues in which they have formed. Von Mosengeil has shown in a series of experiments on rabbits that lymph and waste products in a joint can be forced out into the ascending lymphatic trunks of the limb by the employment of this form of massage. It has proved valuable in the hands of the writer in cases of recent sprains, chronic synovitis, rheumatic and gonorrhœal affections of joints, and in certain cases of strumous synovitis; the size of the joints being much reduced, and the nutrition of the limb greatly improved under careful systematic manipulation.

Tapping (*tapotement*) is the term applied to a series of blows given rapidly with the ulnar edges of the extended hands or with the semiflexed dorsum of the fingers, as also with percutors. This is used over the more fleshy parts and the abdomen. When employed in abdominal massage the effect is the same as that produced by kneading, with the addition of a contraction of the muscular walls. This contraction is also noticed in the muscles of the limbs, with the result that the blood-vessels are dilated, more rapid material exchange occurs in the organ, and at the same time it is roused to action in cases when without the rapid mechanical stimuli the muscle would remain passive.

Having noticed the distinct effects of the different manipulations which are included under the general term massage, it now remains to consider the results of the whole process.

As observed after a month of daily *séanees* the effects on the skin may be briefly summed up thus :—

The integument becomes softer and more pliable, fitting the subjacent tissues more accurately than before, if one may so say; these conditions being particularly noticeable in persons suffering from one or other form of cachexia. The veins become more distinct, and the colour, especially where there has been anæmia, is increased; sensation is improved, whereas "ticklishness" decreases, and the patient generally experiences what is described as a feeling of freshness, perhaps properly referable to the nervous system, but from the writer's own experience it is distinctly a skin impression. The immediate effect of massage is rather to deaden sensation, as noticed by Douglas Graham, who observed that numbness is produced even to the extent of allowing the insertion of a hypodermic needle without the prick being felt; but the after-effect points to the better nutrition of the skin and nervous system, as the following observations on the sense of locality go to show.

In three cases of persons in ordinary health no effect was produced other than that which was common to nine, viz. decrease of the sense immediately after each sitting, a condition coinciding with what Landois observed in experimenting on æsthesiometry after muscular exertion.

In six cases of healthy persons, after seven days' massage (each sitting lasting half an hour) of the upper extremities, it was found that the spot touched by the instrument was more accurately indicated by the patients than before the commencement of the course, and the points could be more nearly approximated, the patient still discriminating them, than before the limbs were manipulated; this refinement of tactile sensibility increased *pari passu* with the massage up to a certain degree, which was reached in some cases earlier than in others.

In the tenth case tested the patient had suffered from hemiplegia and still lacked the power to use the left upper extremity when he came under treatment. The "local sense" was much less in the affected than in the sound limb; but after fourteen days' massage the power to localise the point of the instrument became equal in both limbs, while the differentiation sense was certainly improved; though after six weeks' treatment the right limb was still better endowed than the left.

The observations by Weir Mitchell and others on the temperature of persons suffering from anæmia, neurasthenia, and other diseases before and after massage, induced the writer to note the temperature of healthy individuals who were good enough to subject themselves to experimental massage. Careful precautions were taken to ensure accuracy in the registration of the thermometry, and to maintain the temperature of the room uniformly at 65° F.

The result of the observations on the axillary temperature in twenty cases of healthy adults was that at the close of each sitting the temperature rose, the increase varying from ·6° F. to 1° F; but in all cases it fell after two hours to a degree below that which was noted immediately on ceasing manipulation. In more than one hundred observations a similar result has been obtained, leading to the conclusion that massage temporarily increases the general body temperature. The temperature of a limb after ten minutes' massage has also been found to be higher than that of its fellow of the opposite side, the difference amounting in most cases to 4° F.

The increase in the free surface temperature of a part directly after massage varies with the situation and with the difference between the temperature, taken before massage, of the axilla and that of the free cutaneous surface of the part, *e.g.* in the case of a healthy adult before massage the axillary temperature was 98·8° F., the free surface temperature of the palm of the left hand was 90° F. Directly after massage of the left upper extremity the palmar temperature was 97° F., the axillary temperature rising on the same side to 99° F., and remaining normal on the opposite side.

This may be taken as a typical example of what has occurred under the writer's observation both in health and disease, and certain deductions may be made from this fact of greater heat production in a part manipulated. (1) That the rapidity of the local circulation is increased; (2) the quantity of blood in the part is increased, and the metabolism of tissue in the part is increased; for in view of the results in cases of anæmia, neurasthenia, and muscular atrophy, it can hardly be doubted that all three conditions named above take part in the production of the heat increase which follows massage.

Exercise of a limb till the muscles are exhausted produces a rise in temperature in the same degree as massage, but with the difference that the circumference of the limb is temporarily increased, while by massage it is decreased; aching and fatigue follow exercise, even to the extent of powerlessness, while massage produces neither pain nor exhaustion, but removes both.

Cases have been reported in which massage has been followed by a reduction of temperature; this has not been my experience, except when abdominal massage has been practised alone or at the close of a sitting. Then the temperature of the extremities, and notably of the hands and feet, has been reduced in some cases to the extent of five or six degrees F., the axillary temperature also falling in a few instances as much as 2° F.

Massage of the neck, as practised by Gerst of Würzburg, has been employed by the writer in cases of severe hemicrania and other neuralgic conditions of the head and face in which the surface temperature of the affected part has been above normal, with varying success, but with the constant result of reducing the temperature of the frontal and parietal skin.

The effect of massage on the respirations has been in my experience invariably the same, viz. that they are increased in depth and frequency when the attention of the patient to the process he is undergoing has not caused him to breathe slightly and irregularly, as is often the case when he is interested in the manipulations.

Observations made by the writer on the bodily weight of ten healthy persons taken before, during, and after twenty-eight days' general corporeal massage, without rest from the usual occupation, confirmed those previously made by Dr. F. Gopadze in reference to the assimilation of food during a course of massage to which he subjected healthy individuals. In the ten cases under my observation the weight almost invariably fell some ounces during the first week, and rose steadily during the second, third, and fourth weeks, the greatest gain in the twenty-eight days being eight pounds naked weight. In all cases the appetite increased, sometimes in the first week, but more markedly in the second, at the end of which the weight was usually increased from nearly one to four pounds, and continued rising to the end of the course.

One individual, 5 ft. 6 in. in height, and very stout, lost ten pounds in weight during the course; but while there was a loss of fat there was a gain of strength. These experiments were made without interfering at all with the diet, habits, or occupation of the subjects; but the results appear to justify a fairer appreciation of the value of systematic massage alone than has been shown by some who have obtained startling results by the prosecution of the Weir Mitchell treatment, in which it plays an important part.

In cases of "suppressed gout" treated by massage without rest and seclusion, the writer has known of fifteen pounds' gain in weight in five weeks; but of course where rest, "over-feeding," and seclusion are included in the treatment, the gain is sometimes greater in those cases which are benefited by the treatment.

There is one disease in which massage appears to be of great value, not only because it certainly is followed by an increase in weight of the patient, but in preventing the distortion which frequently follows, I mean anterior cornual myelitis. The writer has had two opportunities of testing the value of massage in this respect while engaged in making the experiments of which this paper is a record, and the apparently good results of careful systematic massage in one case, which had previously been subjected to "medical rubbing" with the untoward effect of rendering the patient exceedingly emotional and much distressed at the prospect of the "rubber's" advent, induces him to mention the subject, as massage is often blamed as an agent for evil when a careful enquiry proves that the patient has been subjected to such rough handling that the marvel is how the sufferer or those interested in the patient could submit to it. If the physiological effects of massage are to be rendered serviceable in the treatment of disease, and to be recognised as valuable in certain cases, the practice of the manipulations must not be entrusted to the hands of unskilled and ignorant performers. The results obtained on the Continent by medical men of acknowledged reputation have been gained by the use of their own hands, or at any rate under their personal supervision and by those whom they have themselves instructed in the method.

It is not that there is any difficulty in acquiring the mechanical movements, which are comparatively simple, but it is the failure to appreciate the delicacy of the structures and the effects of the treatment employed, that renders it necessary that persons to whom the practice of massage is usually relegated should not be permitted to exercise the function in cases where more harm than good must follow on careless and ill-regulated manipulation.